Proceedings of the 72nd World Foundry Congress
21-25th May 2016, Nagoya, Japan

High performance cast parts. Advanced feeding systems for metallurgical optimization

J.Prat[1], G.Artola[2], G.Trillo[2] and J.Izaga[2]
[1] ASK-Chemicals España, S.A.U., C/ Autonomía nº4-2º, 48940 Leioa (Bizkaia), Spain
[2] IK4-Azterlan, Aliendalde Auzunea 6, 48200 Durango (Bizkaia), Spain

Foundry sector, as a whole, has incorporated relevant technological advances into productive processes. Nevertheless, the specific field of feeding system design criteria hasn't improved in the same proportion. The use of simulation tools doesn't always come together with the optimization of key indicators. Part rework costs remain unchanged, yield values hardly reach 50% and the metallurgy of the processed alloys is kept under nearly unchangeable principles.
With this starting point, a deep review of the feeding systems that are employed for the manufacture of cast steel components is carried out, to lead in the end, to the identification and assessment of the metallurgical advantages that can be exploited in the most thermally affected zones and to the net/gross yield optimization.
A complex variable matrix has been defined and studied, taking into consideration high added value materials, their metallurgy both in liquid and solid state, novel feeding devices such as core-risers, riser-paddings and EXACTCAST™ (patented) mini-risers, and advanced simulation concepts.
The most important achieved results are exposed which, taking advantage of the new feeding technologies, allow reaching yields over 75%, with an optimized metallurgical quality in the final product.

Keywords: *Mini-risers, thermal modulus, metallurgical quality, net/gross yield.*

1. Introduction

Previous work from the authors [1] has been referred to advanced feeding systems in small cast steel parts. In this work, it has been considered necessary to apply the previously developed knowledge, in order to solve the feeding problems in big steel castings.

The couple of terms "advanced feeding systems/ big sized parts" in this paper and the results that are presented, are properly backed-up by industrial practice.

2. Experimental procedure

The previously developed calculation methodologies, mainly based in the concept of thermal modulus, are applied. Thus, it has been necessary to characterize, the from thermo-physical point of view, the mixtures employed in the new feeding devices.

2.1 Feeding system design

The conception of the feeding systems must answer the thermal modulus and volume requests, so that shrinkage related incidences are minimized. These studies have been performed for super-duplex alloys and carbon steels.

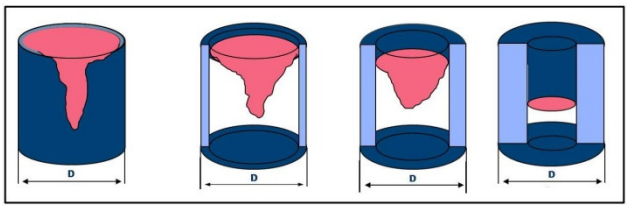

Fig. 1. Different mixtures sand, insulating, exothermic-insulating and mini-risers [1].

2.2 Molding systems

A variable of special relevance, not always taken into account, is the relationship between the molding system and the superheating needs. It has been verified that the molding system exerts a great influence on the metal's castability and, in consequence, on the superheating requirements, that can be very unfavorable in terms of shrinkage defects.

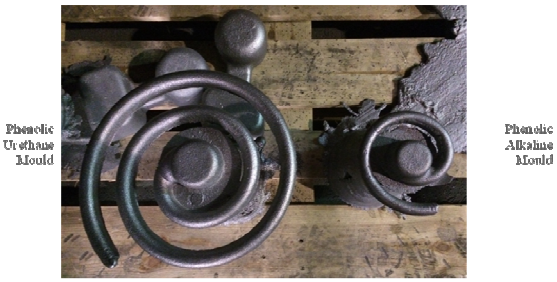

Fig. 2. Castability tests.

Regarding the feeding system design, the application of the exothermic paddings has been found remarkable since, combined with mini-risers, offer great benefits in terms of yield and postprocessing costs.

Fig. 3. Mini-riser with an 34.500cc exothermic padding.

2.3 Industrial trials

Once the feeding systems are designed, the corresponding manufacturing batches are performed, so that conventional and advanced feeding systems can be compared. As an average value, 77% yield has been achieved with the advanced feeding solutions.

3. Results and discussion

The presented results are related to big sized cast components that have been processed in several alloys.

3.1 Hot tearing

The severe thermal gradients that are generated in section changes, frequently lead to cracks of thermal origin. A fine tuning of the simulation models allows realistic predictions that can be used as hot tearing indicators.

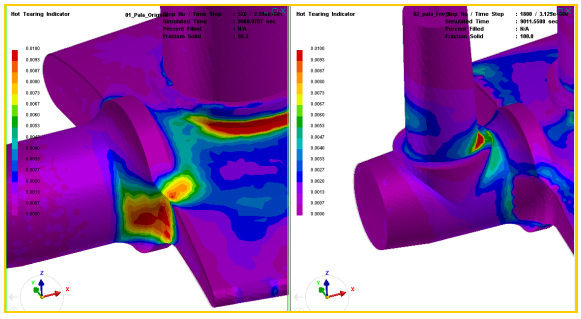

Fig. 4. Thermal stress analysis.

It has been verified that the thermal gradients and the sharp section changes in the set "part-feeding system" are critical and, if the thermal characteristics of the feeding system are properly designed, hot tearing can be strongly reduced and even disappears when using mini-riser.

3.2 Influence on microstructure

Super-duplex alloys are especially sensitive to the presence of micro-precipitates that are directly related to a reduction in mechanical properties and corrosion resistance. Employing mini-risers is very beneficial in order to reduce these negative effects, as they allow a more precise control of solidification sequence.

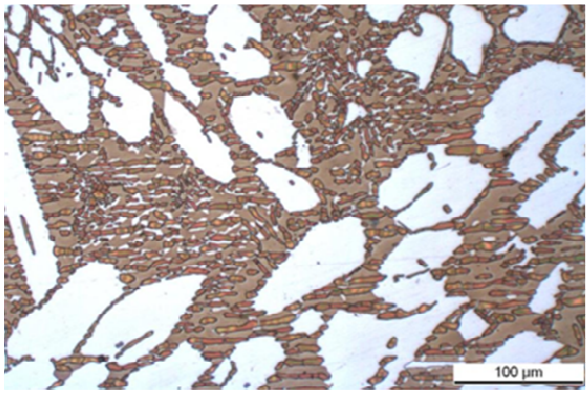

Fig. 5. Micro-precipitates with standard risers.

4. Conclusions

The development of advanced feeding systems (mini-risers and paddings) is a competitiveness key point, both in terms of profitability (net/gross yield) and in terms of technological advantages. The industrial application of mini-risers is an efficient and effective tool for the optimization of the metallurgical quality of cast parts.

Acknowledgements

Our most grateful acknowledgement to the foundries that have helped in developing the studies behind this paper, Fundiser, S.A., Fondesal, S.A., Ebroacero, S.A. and Pyrsa, S.A.

References

[1] A.Carrasco, D. Peña, G.Trillo, J.Prat, J.Izaga, M. Manzanares : 71st World Foundry Congress, Bilbao (2014).

[2] J. Prat: VIII International Foundry Technical Forum, Bilbao (2013).